31.5 Phamplets 249/1 13
7891

PORTLAND CEMENT STUCCO

BULLETIN No. 22

REVISED EDITION

CONCRETE FOR PERMANENCE

PUBLISHED BY
PORTLAND CEMENT ASSOCIATION
111 WEST WASHINGTON STREET
CHICAGO

A REQUEST TO THE READER

FREE HELP

SHOULD you find this bulletin helpful in building with concrete, we would consider it a favor to have you so inform us. Likewise, we would appreciate a description (and a photograph, if possible) of what you have built. In this way you will assist us in aiding others in the same way we trust we have helped you.

If you do not fully understand any part of this book, or if you desire further information, we would be glad to have you write to the

PORTLAND CEMENT ASSOCIATION
111 WEST WASHINGTON STREET
CHICAGO

PORTLAND CEMENT STUCCO

CONCRETE FOR PERMANENCE

⁂

PUBLISHED BY THE
PORTLAND CEMENT ASSOCIATION
111 WEST WASHINGTON STREET
CHICAGO

Table of Contents

SUBJECT PAGE

STUCCO

Amount of Lime Used 5
Applied on Concrete Block 22
Applied on Metal Frame Structures 28
Applied on New Frame Structures 28
Applied on Old Brick Structures 19
Applied on Old Frame Structures 21
Applied on Old Stone Structures 20
Coloring and Surface Finishes 28
Composition 5
Furring Strips 26
How to Apply 10
Lath 7
Origin 3

SPECIFICATIONS (Page 10)
Brick, Tile and Block Surfaces 14
Finish of Surfaces 16
Machine Stucco 17
Materials 10
Mortar Coats—Application, Proportions, Thickness, etc. 14
Overcoating 17
Preparation of Mortar 11
Structure for Metal Lath 11
Structure for Wood Lath 13

Copyright, 1915, Association of American Portland Cement Manufacturers

Portland Cement Stucco

Early Use

THE use of stucco dates back to almost prehistoric ages. In its earliest application it was made use of as a plaster of mud to cover a framework of reeds or rough-hewn timbers, as a means of keeping the house warm and of excluding the rain. Later houses were built of sun-burned straw brick and rough stone, and to produce a better and more pleasing appearance the exterior was covered with mud plaster, which baked hard in the hot sun. These uses, however, were confined to warm climates where the action of frost would not tend to disintegrate the poor material then available.

The Greeks and Romans developed the use of stucco to a high degree; some of the finest examples of fresco and inlaid tile work are to-day preserved in stuccoed surfaces.

In this country the use of stucco dates back to some of our earliest structures; many of the adobe houses of Mexico, New Mexico, and southern California have their exteriors finished with a mud plaster. The old Mission houses of the southwest—priceless relics of a by-gone age—have stuccoed exteriors. This kind of work, however, could only last in warm, dry climates.

As the use of stucco by the ancients was intended to give an added protection and more pleasing appearance, so to-day we use stucco for the same purpose, but instead of the perishable mud plaster or the semi-hydraulic cement of the Romans, we have the very highly developed product, exact in manufacture, uniform in action, and permanently enduring—Portland cement.

Modern Use

The modern use of Portland cement stucco has grown with great rapidity, both for the purpose of renovating old buildings and also for exteriors of brick and frame structures. Until recently architects when using cement plaster and concrete endeavored to imitate some other building material, usually stone, but this could never be successful.

Stucco to-day is being used for two purposes—to form the outer wall of a building or to renovate an existing structure by giving it a more pleasing appearance.

Many old buildings of brick, stone, or wood have been beautified by the simple method of applying a coating of cement stucco. This forms a permanent finish. The modern Portland cement, as stated before, is a hydraulic cement, the small addition of lime having no effect on this property, and, owing to its power to become hard in water, it continues to grow in strength. Exposure to rain has no effect except to assist in this hardening.

Portland cement stucco means permanent structures at reasonable cost.

There are sometimes conditions where stucco is the only practical method of securing satisfactory results. Fig. 1 is an example. The walls of this round-house are entirely composed of this material. The old house of wood was destroyed, and it was considered advisable to put in a more lasting structure. The foundations, however, were too light to carry a house of heavier material than wood. A frame of structural iron was erected, and the walls made of stucco. This work has been standing for six years, with perfectly satisfactory results.

Constituents of Stucco

Stucco is a mixture of Portland cement and sand, with the addition of about one part of lime to ten parts of cement. The lime may be either hydrated lime or slaked lump lime.

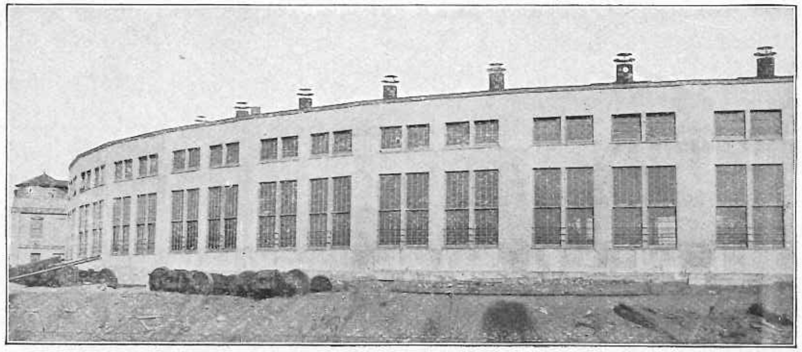

Fig. 1.—Round-house of Baltimore and Ohio Railroad at Philadelphia. Structure, iron framework, with walls of stucco.

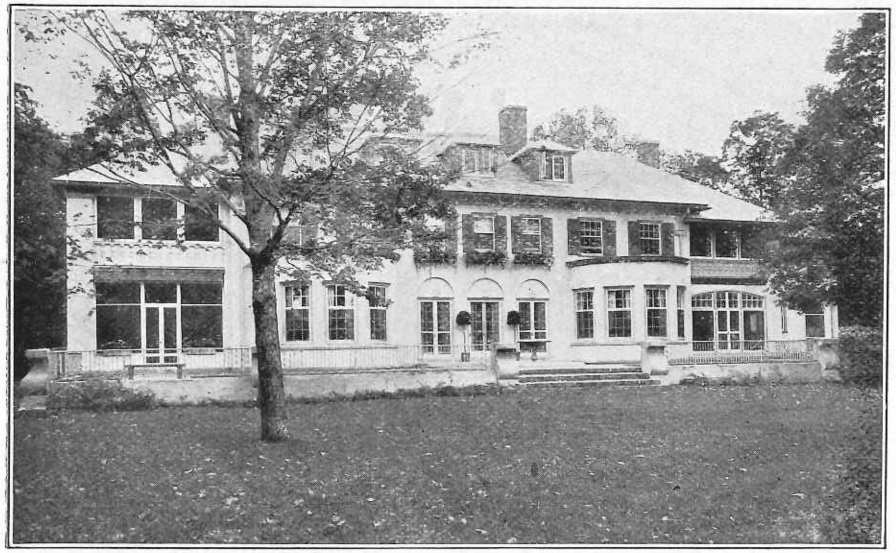

Fig. 2.—Residence of stucco on concrete blocks showing attractive appearance of this combination.

Hydrated lime is lump lime slaked with water by a mechanical process, the moisture driven off, leaving the lime dry, in the form of an impalpable powder.

The advantage of using hydrated lime lies in the fact that the work of slaking or hydrating is done mechanically, with the result that the lime is never burned and is all thoroughly slaked. There is then no danger of placing any unslaked material in the plaster, and the hydrated lime never air slakes. It comes in convenient sized packages so that the user can readily mix just the right quantity. If it is impossible to obtain hydrated lime, ordinary lump lime can be used. In this case slake good double-strength lime in plenty of water and stir only enough to prevent the large lumps from burning. After being allowed to stand for a week or ten days it is ready for use.

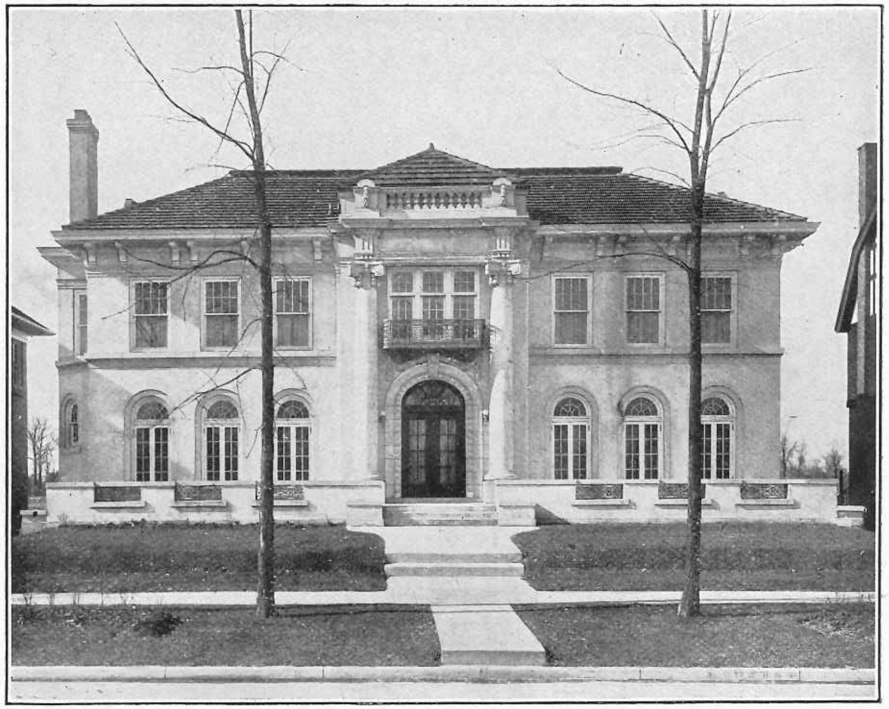
Fig. 3.—That the use of stucco is not confined to small structures is illustrated by this large and handsome house.

The lime is usually slaked in a box raised slightly from the ground, one end being lower than the other, so that the slaked lime will run off. The lower end should have a sliding door, with the opening covered with a coarse wire screen, which acts as a strainer, thus preventing any unslaked lumps from leaving the box. After the lime has completely slaked it is run off into a crater of sand and the lime and sand are thoroughly mixed, enough sand being used to form a thick paste. About 1 part of lime putty to 9 parts of sand are needed. The cement and remainder of the sand are added just before the plaster is applied, and only a small quantity should be prepared at a time. The cement sets rapidly, and if this occurs before application it will lose its value. If a large quantity of the cement lime mixture were prepared, the cement would set before it could be used. This is an important point to be observed, and if neglected causes failure.

The addition of this amount of lime to the cement plaster makes it more impervious to moisture, and at the same time fattens the mortar so that it will cover more surface and work easier under the float. The final mixture of cement, sand, and lime should be wet enough to work easily, but stiff enough to prevent any flowing after it is applied.

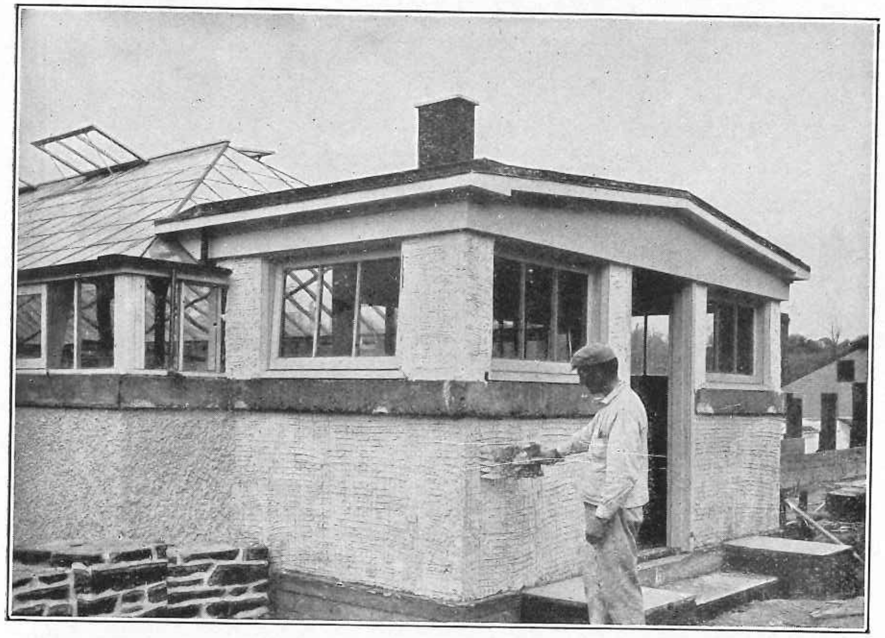
Fig. 4.—Stucco on concrete. Roughening the first coat with saw-toothed paddle.

Lath for Stucco Work

There are two general types of lath upon which stucco is applied—expanded metal lath, close-meshed wire lath, and wood lath. In addition there are on the market a number of patented stucco or plaster boards, designed to take the place of ordinary lath.

The wood lath is the ordinary narrow lath with which every one is familiar. Expanded metal lath consists of metal sheets about $\frac{1}{40}$ inch in thickness, which are slotted and expanded to form mesh of various shapes. Woven-wire lath is a close-mesh wire cloth provided with wire stiffeners.

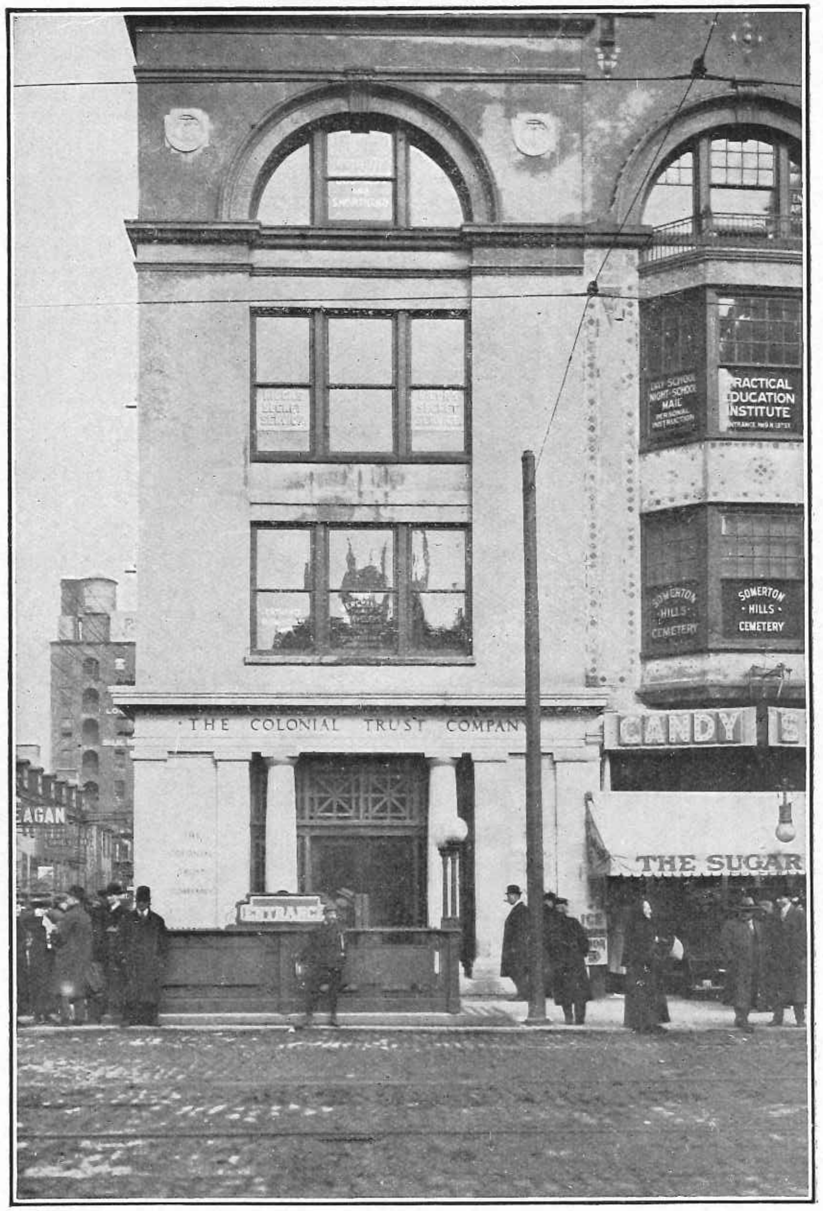

Fig. 5.—Portland cement stucco finish on wire.

Since it is essential that metal lath should be protected against corrosion, two methods are used to embed completely the lath in stucco. One method is to plaster the back of the lath, thus completely embedding same; the other method is to use sheathing board on which to fasten the lath.

When using the latter method, in order that the first coat will have a proper bond with the lath, it is absolutely essential that the stucco of the first coat is forced through the lath and into full contact with the sheathing boards. When this is properly done, the lath will be embedded entirely in the stucco, thus obviating the necessity of plastering on the back of the lath. In the specifications which follow both methods are given.

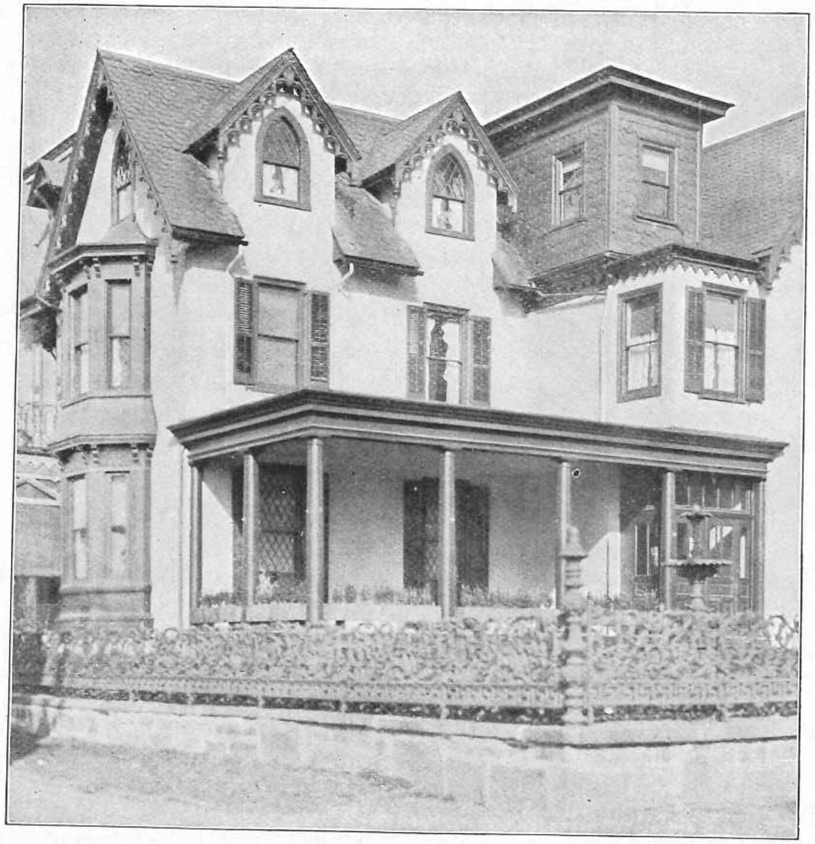

Fig. 6.—Portland cement stucco on stone.

Manufactured stucco board is generally used to reduce the cost of wood and metal lathing. In deciding upon the use of stucco board great care must be exercised in order that a rigid, strong product is secured—

one that will add to the stability of the structure. There are on the market stucco boards which have nothing to recommend them but their cheapness, and these must be avoided in selecting. Stucco board is sold in sheets ready to apply.

How to Apply Stucco

Any material may be ruined if improperly handled, but when properly made and applied, Portland cement stucco will endure for an indefinite time.

When Portland cement is wet and allowed to stand undisturbed, it hardens and adheres to the material with which it is in contact. When cement plaster is applied to a dry surface which will absorb moisture, this adhesion cannot take place; or if a freshly plastered surface is exposed to the heat of the sun, which will dry it out too quickly, the water will be evaporated from the cement and prevent its proper hardening.

The plaster must not be allowed to dry out too rapidly. If it is exposed to the sun, it must be covered with a wet canvas or the surface frequently sprayed. If the cement freezes before it has set, the water will, of course, turn to ice and the cement will not harden. Stucco should never be applied when the temperature is below freezing. It is also apparent that if the cement is disturbed during the time of hardening, or, as we term it, during the period of set, its adhering quality is ruined and the stucco will not hold. Cement should never be disturbed after it has started to set.

*Specifications for Portland Cement Stucco on Metal Lath, Wood Lath, Brick, Tile or Concrete Block,

Paragraphs marked (a) apply only to back-plastered walls without sheathing.
Paragraphs marked (b) apply only to walls with sheathing.
All other paragraphs apply to both forms of construction.

Materials.

Cement.—The cement shall meet the requirements of the Standard Specifications for Portland Cement of the American Society for Testing Materials, and adopted by this Institute (Standard No. 1).

Fine Aggregate shall consist of sand, crushed stone, or gravel screenings, graded from fine to coarse, passing when dry a screen having ⅛ in. diameter holes, shall be preferably of silicious materials, clean, coarse, free from loam, vegetable or other deleterious matter.

Lime.—The lime shall be thoroughly hydrated either by the manufacturer, or the contractor. If hydrated by the contractor, it shall be slaked in sufficient water to make a soft paste and allowed to stand at least one week before being applied to the wall.

---

* These specifications have been adopted as Standard and have been copyrighted by the *American Concrete Institute*, 1418 Walnut Street, Philadelphia.

Hair or Fibre.—There shall be used only first quality long hair, free from foreign matter, or a long fibre well combed out.

Coloring Matter.—Only inorganic colors shall be used which are not affected by lime, Portland cement, other ingredients of the mortar, or the weather.

Water shall be clean, free from oil, acid, strong alkalies or vegetable matter.

Preparation of Mortar.

Mixing.—The ingredients of the mortar shall be thoroughly mixed to a uniform color, sufficient water added to obtain the desired consistency, and the mixing shall continue until the cement and lime are uniformly distributed and the mass is uniform in color and homogeneous.

The hair or fibre shall be added during the process of wet mixing.

Measuring Proportions.—Methods of measurement of the proportions of the various ingredients, including the water, shall be used which will secure separate uniform measurements at all times. All proportions stated are by volume. A bag of cement (94 lb. net) shall be assumed to contain 1 cu. ft. Lime when used shall be measured in the form of putty. Hydrated lime shall be made into putty before being measured.

Quantity.—There shall not be mixed at one time more mortar than will be used within one hour. Mortar which has begun to stiffen or take on its initial set shall not be used.

Hand Mixing.—The mixing shall be done on a water-tight platform and the materials shall be turned until they are homogeneous in appearance and color.

Consistency.—The materials shall be mixed so as to provide sufficient water to insure a proper bonding and a dense mortar free from voids.

Retempering.—Retempering mortar, *i. e.*, remixing with water after it has partially set, shall not be allowed.

Structure (When Using Metal Lath).

Framing.—Studs spaced at 12-in. centers wherever possible shall be run from foundation to rafters without any intervening horizontal grain in the wood. These studs shall be tied together just below the floor joists by 6-in. boards which will be let into the studs on their inner side, so as to be flush and securely nailed to them. These boards will also act as sills for the floor joists, which in addition will be securely spiked to the side of the studs.

Bracing.—The frame of the building shall be so rigidly constructed and braced as to avoid cracking the stucco.

(*a*) At least once between each two floors, brace between the studding with 2 x 3 in. bridging.

(*b*) Bracing may be omitted, as the sheathing boards act as bracing.

Sheathing.—(*a*) The lath is to be fastened direct to the studding and back-plastered and no sheathing boards are to be used.

(*b*) Sheathing boards shall be not less than 6 in. nor more than 8 in. wide, dressed on one or both sides to a uniform thickness of ⅞ in. They shall be laid diagonally across the wall studs and fastened with two nails at each stud.

Inside Waterproofing.—(*a*) The faces of the studs and for one inch back of the face on each side, where the plaster may come in contact with them, shall be thoroughly waterproofed with tar or asphalt.

(*b*) Over the sheathing boards shall be laid in horizontal layers, beginning at the bottom, a substantial paper well impregnated and thoroughly waterproofed with tar or asphalt. The bottom strip shall lap over the base board at the bottom of the wall, and each strip shall lap the one below at least 2 in. The paper shall lap the flashings at all openings. When required, the lower horizontal edge of each strip shall be cemented with hot or liquid tar or asphalt compound to the strip below and to the grounds of flashings at all openings. All tacking shall be within 2 in. of the top horizontal edge, where tacks will be covered by the lap of the strip above.

Furring.—When furring forms a part of the metal lath to be used, then separate furring as described in this paragraph is to be omitted.

(*a*) Galvanized or painted ½-in. crimped furring, not lighter than 22 gauge or other shape giving equal results, shall be fastened direct to the studding, using 1¼-in. x 14-gauge staples, placed 12 in. apart.

(*b*) Galvanized or painted ½-in. crimped furring, not lighter than 22 gauge or other shape giving equal results, shall be fastened over the sheathing paper and directly along the line of the studs, using 1¼-in. x 14 gauge staples, placed 12 in. apart. The same depth of furring should be adhered to around curved surfaces, and furring shall be placed not less than 1½ in. or more than 4 in. on each side of and above and below all openings.

Preparation of Original Surface.—All roof gutters shall be fixed and down-spout hangers and all other fixed supports and fasteners shall be put up before the plastering is done, so there will be no break made in the plastering where they are permanently fixed.

Wall copings, balustrade rails, chimney caps, cornices, etc., shall be built of concrete, stone, tile or metal with ample overhang drip grooves or lip, and water tight joints, to keep water from behind the plaster.

If wood sills are used, they should project well from the face of the plaster and have ample drip groove or lip.

Metal lath shall be stopped far enough above the level of the ground to be free from ground moisture.

Care should be taken to provide for placing all trim the proper distance from the studding or furring to show its right projection after the plaster is on.

Lath.—The lath shall be not thinner than 24 gauge, galvanized or painted, expanded metal lath weighing not less than 3¼ lbs. to the square yard, or woven wire lath, galvanized or painted, 19 gauge 2½ meshes to the inch with stiffeners at 8-in. centers.

Application of Lath.—Place lath horizontally over the furring driving galvanized staples 1¼-in. x 14 gauge 8 in. apart over the furring into the studding. The sheets of lath shall be locked or lapped at least 1 in. and tied at joints between studs both vertically and horizontally with 18-gauge wire.

Corners.—There shall be 6-in. strips of metal lath bent around the corners and stapled over the lath, or the sheets of metal lath shall be folded around the corners a distance of at least 3 in. and stapled down, as applied. Galvanized corner bead may be applied over the lath.

Insulation.—(*a*) After the lath on the outside has been back-plastered, the air-space may be divided by applying heavy building-paper, quilting, felt or other suitable insulating material between the studs, fastening it to the studs by nailing wood strips over folded ends of the material. This insulation should be so fastened as to clear the bridging, leaving the preponderance of the air space next to the plaster. Care must be taken to keep the insulating material clear of the outside plaster and to make tight joints against the wood framing at the top and bottom of the spaces and against the bridging where the face intercepts.

(*b*) When quilting, felt, or other insulating material is to be used it shall be applied to the sheathing boards under the inside waterproofing.

Structure (**When Using Wood Lath**).

Framing.—Studs spaced at not more than 16 in. on centers shall be run from foundation to rafters without any intervening horizontal grain of the wood. These studs shall be tied together just below the floor joists by 6-in. boards which will be let into the studs on their inner side, so as to be flush and securely nailed to them. These boards will also act as sills for the floor joists, which in addition will be securely spiked to the side of the studs.

Sheathing.—Sheathing boards shall be not less than 6 in. or more than 8 in. wide, dressed on one or both sides to a uniform thickness of ⅞ in. They shall be laid diagonally across the wall studs and fastened with two nails at each stud.

Insulation.—When quilting, felt, or other insulating material is to be used it shall be applied to the sheathing boards under the inside waterproofing.

Inside Waterproofing.—Over the sheathing boards shall be laid in horizontal layers, beginning at the bottom, a substantial paper well impregnated and thoroughly waterproofed with tar or asphalt. The bottom strip shall lap over the base board at the bottom of the wall, and each strip shall lap the one below at least 2 in. The paper shall lap the flashings at all openings. When required, the lower horizontal edge of each strip shall be cemented with hot or liquid tar or asphalt compound to the strip below and to the grounds of flashings at all openings. All tacking shall be within 2 in. of the top horizontal edge, where tacks will be covered by the lap of the strip above.

Furring.—Furring ⅞ in. thick by 2 in. wide shall be laid vertically 12 in. on centers over sheathing paper and nailed every 8 in. with 5*d* nails.

Preparation of Original Surface.—All roof gutters shall be fixed and down-spout hangers and all other fixed supports and fasteners shall be put up before the plastering is done, so there will be no break made in the plastering where they are permanently fixed.

Wall copings, balustrade rails, chimney caps, cornices, etc., shall be built of concrete, stone, tile or metal with ample overhang drip grooves or lip, and water-tight joints, to keep water from behind the plaster.

If wood sills are used, they should project well from the face of the plaster and have ample drip groove or lip.

Lath shall be stopped far enough above the level of the ground to be free from ground moisture.

Care should be taken to provide for placing all trim the proper distance from the studding or furring to show its right projection after the plaster is on.

Lath.—The lath shall be standard quality narrow plastering lath 4 ft. long and not less than ⅜ in. thick.

Application of Lath.—Single layer work. Lath shall be placed horizontally on the furring with ½ in. openings between them. Joints shall be broken every twelfth lath. They shall be nailed at each furring with 4*d* galvanized nails.

Double layer work. The lath shall be applied in two layers. Both layers shall be placed diagonally to the furring in opposite directions, the angle being such that the 4-ft. lath will span three spaces between furring. The space between lath for key shall be 1 in. in each layer. Joints shall be broken every twelfth lath in each layer. The first layer shall be applied directly to the furring and nailed with 4*d* galvanized nails at every point of contact. A second layer of lath shall be applied over the first with joints broken; *i. e.*, ends of lath of the second layer shall not come over the same furring as those of the first layer. The second layer shall be nailed to each furring with 4*d* galvanized nails.

Corners and Openings.—Around all openings and bent-over corners place a 6-in. strip of galvanized metal lath firmly stapled over wood lath with 1¼-in. x 14 gauge galvanized staples.

Spraying.—Wet lath thoroughly on both sides and allow water to be absorbed before applying the first coat of plaster.

Brick, Tile or Cement Block Surfaces.

Existing surfaces to be stuccoed shall have all loose, friable or soft mortar removed from the joints to a depth of not less than ½ in. All dirt, dust or any other foreign matter shall be removed by means of a wire brush, stiff broom or other effective means. In case the surface has been painted, is oily or otherwise in such condition that the stucco will not firmly adhere, then metal furring and lathing shall first be applied.

New surfaces shall have ample roughness to assure a strong bond and key between the stucco and the surface. The mortar joints shall not be less than ⅜ in. thick and the mortar shall be omitted from or raked out of the joints for at least ½ in. back from the face to which the stucco is applied. Before placing the scratch coat the surface shall be brushed clean from all dust, dirt or loose particles and thoroughly wetted, and shall be in this condition when the plaster is applied.

Mortar Coats.

Plaster.—(*a*) (*Applies to metal or wood lath.*) The *first coat* shall contain not more than two and one-half (2½) parts of sand to one (1) part of Portland cement by volume. If lime putty is added, it shall not be in excess of one-third (⅓) of the volume of cement. Hair or fibre may be added in sufficient quantity to bond the mortar.

(*b*) (*Applies to metal lath only.*) The *first coat* shall contain not more than two and one-half (2½) parts of sand to one (1) part of Portland cement by volume. If lime putty is added it shall not be in excess of one-third (⅓) of the volume of cement. No hair, fibre or similar material of any kind or in any quantity shall be added to the mortar.

For *second coat*, the proportion of sand to cement shall not be greater than 2½ to 1 by volume, nor shall more than ⅓ part of lime putty be added.

For *third coat*, the proportion of sand to cement shall not be less than 2 to 1 nor more than 2½ to 1, by volume, nor shall more than ⅓ part of lime putty be added.

Application.—The plastering should be carried on continuously in one general direction, without allowing the plaster to dry at the edge. If it is impossible to work the full width of the wall at one time, the joint should be at some natural division of the surface, such as a window or door.

Metal Lath.—(*a*) The first coat shall be applied to the outside of the lath and pushed through sufficiently to give a good key. Over the face of the studs the plaster shall be forced well through the lath in order to fill entirely the space between the lath and the stud. The backing coat shall be applied to the back of the lath and shall be thoroughly troweled so that the lath shall be entirely covered. The final coat shall be applied to the face of the first coat.

(*b*) The first coat shall be applied to the lath and thoroughly pushed through against the inside waterproofing so as to completely embed the metal of the lath on both sides. Special care shall be taken to fill all voids around furring strips and where laths lap.

Wood Lath.—The first coat shall be applied to the outside of the lath and pushed through sufficiently to give a good key. If subsequent coats are applied, they shall be well troweled to insure good bond with the previous coat.

Brick, Tile or Cement Block Surfaces.—The first coat shall be forcibly and thoroughly troweled into the depressions of the previously saturated surface so as to make a firm bond. Care shall be taken to insure the complete filling by the mortar of all crevices and pores.

If subsequent coats are applied they shall be well troweled to insure good bond with the previous coat.

Roughing.—Soon after applying and before the initial set has taken place, the surface of the coats which are to receive succeeding coats shall be roughened with a saw-toothed paddle or other suitable device.

Dampening.—Before applying mortar the surface of the preceding coat shall be thoroughly wetted to prevent absorption of water from the fresh mortar.

Thickness of Coats.—(*a*) The first coat shall be at least ⅜ in. thick over the face of the lath and project through behind the lath about ⅜ in. The backing coat shall increase the thickness behind the lath to not less than ⅝ in. The final coat shall be not less than ⅜ in. thick.

(*b*) The first coat shall have a minimum thickness over the lath at any point of not less than ¼ in. The intermediate coat shall have a thickness of not less than ¼ in. or more than ⅜ in. The final coat shall have a thickness of ¼ in. when placed over an intermediate coat, or of ⅜ in. when placed directly on the scratch coat.

Wood Lath.—The first coat shall have a minimum thickness over the lath at any point of not less than ¼ in. The intermediate coat shall have a thickness of not less than ¼ in. or more than ⅜ in. The final coat shall have a thickness of 1/4 in. when placed over an intermediate coat, or of 3/8 in. when placed directly on the scratch coat.

Drying Out.—The final coat shall not be permitted to dry out rapidly, and adequate precaution shall be taken, either by sprinkling frequently after the mortar has set hard enough to permit it or by hanging wet burlap or other material over the surface.

Freezing.—Stucco should never be applied when the temperature is below freezing.

Finish

Smooth Troweled.—The finishing coat shall be troweled smooth with a metal trowel with as little rubbing as possible.

Stippled.—The finishing coat shall be troweled smooth with a metal trowel with as little rubbing as possible, and then shall be lightly patted with a brush of broom straw to give an even, stippled surface.

Sand Floated.—The finishing coat, after being brought to a smooth, even surface, shall be rubbed with a circular motion of a wood float with the addition of a little sand to slightly roughen the surface. This floating shall be done when the mortar has partially set.

Sand Sprayed.—After the finishing coat has been brought to an even surface, it shall be sprayed by means of a wide, long fiber brush—a whisk-broom does very well—dipped into a creamy mixture of equal parts of cement and sand, mixed fresh every 30 minutes, and kept well stirred in the bucket by means of the whisk-broom or a paddle. This coating shall be thrown forcibly against the surface to be finished. This treatment shall be applied while the finishing coat is still moist and before it has attained its final set, *i.e.,* within 3 to 5 hours. To obtain lighter shades add hydrated lime of 5 to 15 per cent. of the volume of the cement.

Splatter Dash or Rough Cast.—After the finishing coat has been brought to a smooth, even surface and before attaining final set, it shall be uniformly coated with a mixture of one part cement and two parts of sand thrown forcibly against it to produce a rough surface of uniform texture when viewed from a distance of 20 ft. Special care shall be taken to prevent the rapid drying out of this finish.

Pebble Dash.—After the finishing coat has been brought to a smooth, even surface, and before attaining initial set, clean round pebbles, or other material as selected, not smaller than 1/4 in. or larger than 3/4 in. previously wetted, shall be thrown forcibly against the mortar so as to embed themselves in the fresh mortar. They shall be distributed uniformly over the surface of the final coat and may be pushed back into the mortar with a clean wood trowel, but no rubbing of the surface shall be done after the pebbles are embedded.

Exposed Aggregates.—The finishing coat shall be composed of an approved, selected coarse sand, marble dust, granite dust or other special material, in the proportion given for finishing coats and within 24 hours after being applied and troweled to an even surface shall be scrubbed with a stiff brush and water. In case the cement is too hard a solution of one part hydrochloric acid in four parts of water by volume can be used in place of water. After the aggregate particles have been uniformly exposed by scrubbing, particular care shall be taken to remove all traces of the acid by thorough spraying with a hose.

Mortar Colors.—When it is required that any of the above finishes shall be made with colored mortar, not more than 6 per cent. of the weight of Portland cement shall be added to the mortar in the form of finely ground coloring matter.

A predetermined weight of color shall be added dry to each batch of dry fine aggregate before the cement is added. The color and fine aggregate shall be mixed together and then the cement mixed in. The whole shall then be thoroughly mixed dry by shoveling from one pile to another through a 1/4-in. mesh wire screen until the entire batch is of uniform color. Lime putty, if used, and water shall then be added to bring the mortar to a proper plastering consistency.

Machine Stucco.

Stucco may be applied by a machine, provided the results obtained are equal to those produced by hand work.

Overcoating.

During recent years there has come into vogue a method of remodeling old frame houses. This "overcoating", as it is called, is used extensively in all sections of the country and the following practice is recommended:

Where furring is used so deep that the space back of the lath is not entirely filled with plaster, some provision must be made for extending the old window and door frames to correspond with the increased thickness of the wall. In some cases the plaster is brought over the old frames in such a manner that a recessed window or door opening is made. In case the furring is fastened to the studding, it is not necessary to provide for extending the window and door frames, as the new stucco finish will have the same relations as the old weather-boarding.

Preparation of Original Surface.—If the weather-boarding is in poor condition it should be removed and furring and metal lath applied over the sheathing, to which waterproof paper has previously been fastened. It may be advisable also to tear off the sheathing, in which case the furring can be fastened direct to the studding after bracing between the studs.

Another method would be to fasten the furring direct over the weather-boarding over which the metal lath is applied.

In preparation for any of these methods the house should be gone over carefully to determine if the framework is well enough preserved to justify the improvement.

The doors should be looked after, the studding inspected, partitions and outside walls lined up and brought into plumb.

Furring.—Fasten galvanized or painted 1/2-in. crimped furring or other shape giving equal results, vertically over the original surface, whichever of the above may be adopted.

Lathing and Plastering.—Follow the above specifications for stucco.

Renovating Old Brick Buildings

In renovating the exterior of an old brick building the stucco can be applied directly to the brick.

The old mortar joints should be picked out ½ to ¾ inch from the face of the brickwork, and when the first coat is applied it is forced into these crevices and forms an excellent bond.

It is absolutely necessary, however, to thoroughly clean the brick before putting on the stucco. This can be done by scrubbing with a weak solution of 1 part commercial muriatic acid and 5 parts of water. After this is done, thoroughly cleanse the surface with water.

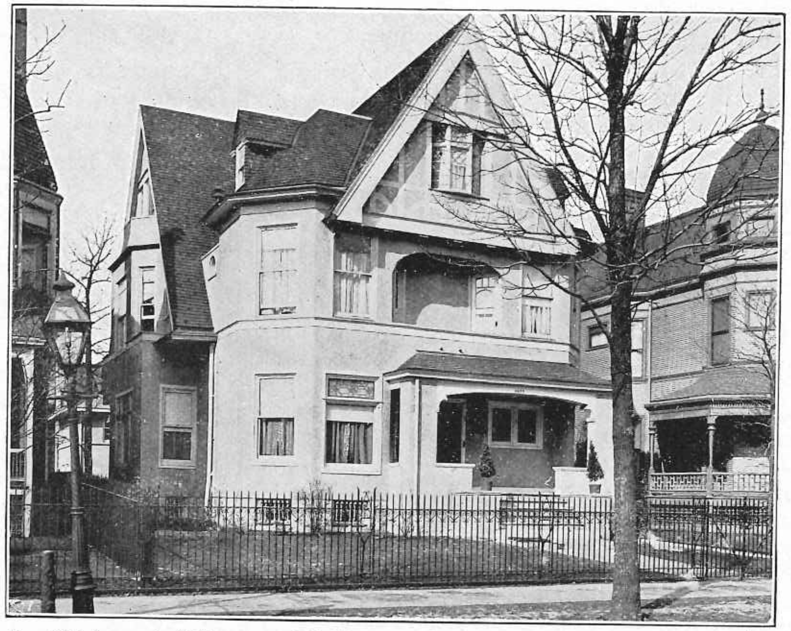

Fig. 7.—Old frame building remodeled by use of cement stucco on expanded metal lath.

Before applying the plaster the surface of the brick wall must be saturated with water, and on account of the porous nature of the brick this must be done with great care.

The plastering should be started at the top of the wall and carried downward. Care should be taken to make the stucco work continuous, that is, one patch of plaster must not be allowed to dry before the adjoining space is covered. If this precaution is not observed, cracks and differences of color are likely to occur in the finished surface. If it is impossible to make the stucco continuous, a stop should be made where there is a natural break in the old surface, such as at a window or pilaster.

Method for Applying Stucco on Old Brick

Pick back the joints between the brick ½ inch.

Clean surface with solution 1 part commercial muriatic acid and 5 parts water.

Wash off acid thoroughly.

Saturate surface thoroughly just before applying plaster, and keep wet as plaster is placed.

Start plastering at top of wall.

Make each coat continuous.

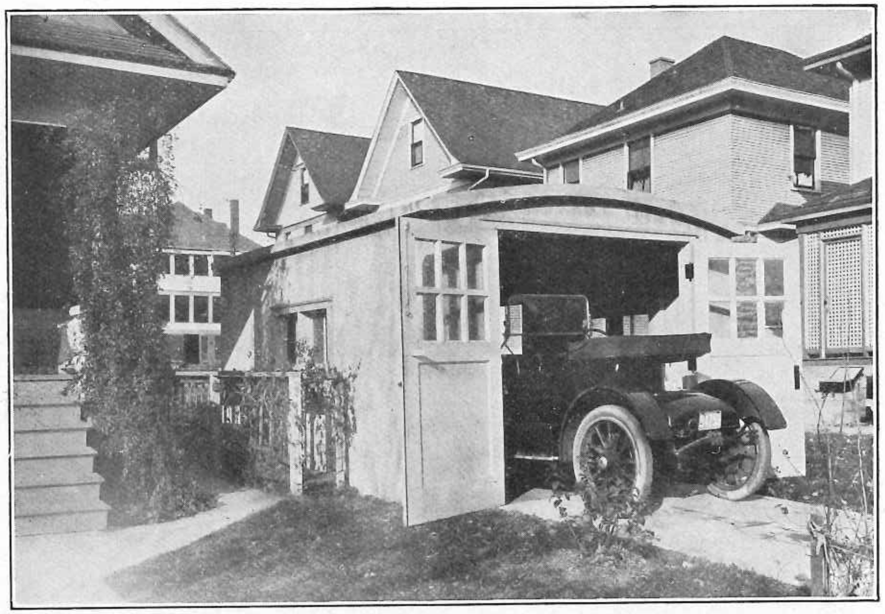

Fig. 8.—The low cost of stucco makes it especially desirable for small garages such as this.

Stops shall be made only where natural breaks occur in the wall surface. If no breaks occur, plaster whole surface from edge to edge in one operation.

For proportions, see Specifications for Stucco (p. 10).

Instead of applying the cement plaster directly to the brick, wire or expanded metal is sometimes first fastened to the brick, and the stucco placed on it. Metal furring strips, placed from 12 to 18 inches apart, are attached to plugs driven in the joints of the brickwork, flush with the surface, and the wire is fastened to these strips. The strips should be ½ inch thick. The stucco is then applied by spreading it over the wire and forcing it into the meshes.

The cut shown (Fig. 5) illustrates the possibilities of cement plaster work. An old brick building of unsightly appearance occupied this site, and a still older and more dilapidated one adjoined it. The present attractive buildings were made possible by applying to the exteriors a coating of cement plaster. The fronts were covered with ordinary chicken-wire furred out about ¾ inch and the cement plaster was forced through the meshes. The finish was obtained from the second coat. In the building used for a store and offices, tiles of various bright colors were embedded in the final coat while it was fresh, and a very artistic result was obtained. The photograph fails to bring out the pleasing appearance of this finish.

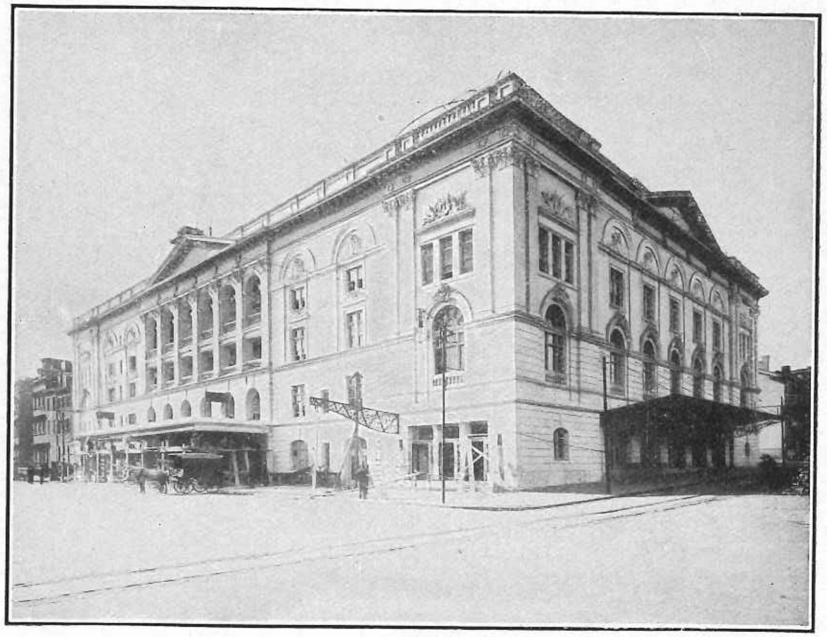

Fig. 9.—Portland cement plaster finish on brick.

Renovating Old Stone Exteriors

Stone exteriors of old buildings can be made to present a very beautiful appearance by the application of cement stucco. In this case, as with brick, the stucco can be applied directly to the stone or to a covering of wire or lath. The work is done in the same way as on brick and the surface of the stone must be cleaned and saturated with water before applying the plaster. It is rather difficult, however, to secure good results in this way, and it would be better to use wire or metal lath over the stone and apply the stucco to it.

The use of stucco on either brick or stone adds greatly to the imperviousness of the old wall, and quite often a coat of plaster to a damp wall, which is severely exposed, will make it perfectly dry.

Renovating Old Frame Buildings

Old frame buildings can be readily renovated by using cement stucco. The exterior is covered with wire or lath furred out as described and three coats are applied. Fig. 7 shows an old frame house remodeled in this way. Any structure with a rigid, well-preserved frame may be improved in a similar manner. On page 17 are given directions for this work under heading of "Overcoating."

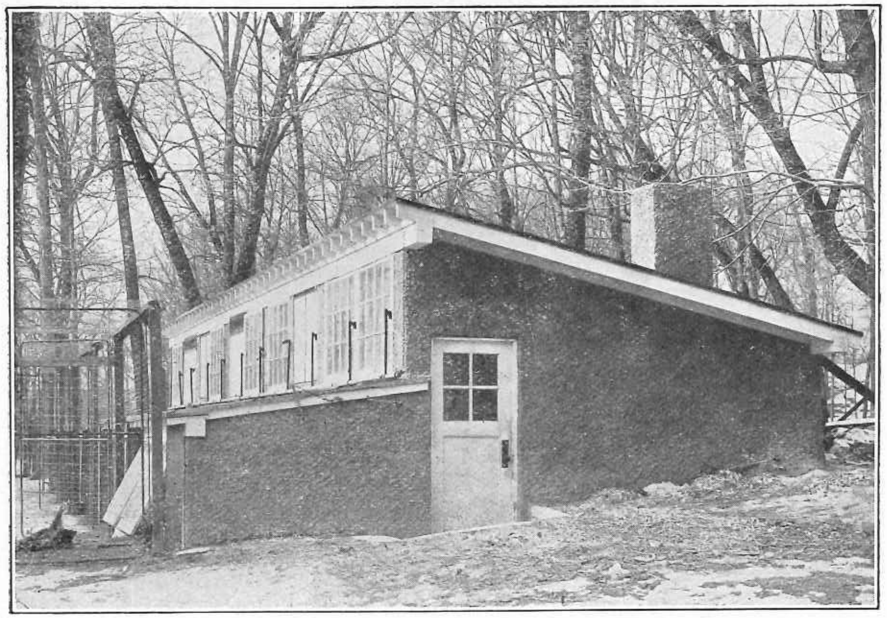

Fig. 10.—Poultry-house of stucco. A house such as this will always be sanitary and free from rats and vermin.

Stucco on New Brick Buildings

Stucco is often applied to new brick buildings with artistic effect. An excellent example of the adaptability of a cement plaster finish is shown in the photograph of the Philadelphia Opera House (Fig. 9). All the pilasters and semicircular arches over the windows, as well as the marquis, are covered with cement plaster. This plaster was composed of 1 part white Portland cement to 2 parts marble screenings with the dust removed. No lime was used. The joints between the bricks were picked back about

¾ inch when they were laid, and the first coat was forced well into the crevices. The second coat was used for finishing. The question of time was an essential feature in the erection of this building, and had stone been used, a considerable delay would have occurred—first in securing the stone, and later in setting it into place. The construction used not only saved time and expense, but enabled the builder to secure a most artistic appearance.

Another instance of the use of cement plaster applied to brick to save time and expense was that of the History Building, at the Jamestown Exposition. This building was started just before the Exposition opened, and had to be completed in the shortest possible time. On account of the valuable collection of relics and paintings it was to contain, an absolutely waterproof wall was essential. The cement plaster coat served both purposes, and by allowing the red brick to show in the pilasters a pleasing contrast was secured.

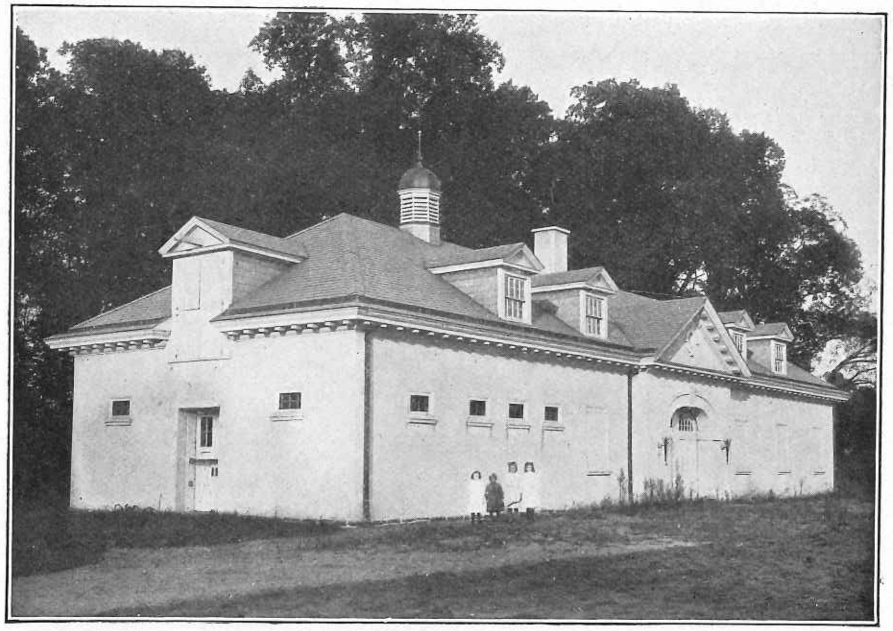

Fig. 11.—Barn of Portland cement stucco.

Stucco on Concrete Block Buildings

The application of stucco to concrete blocks affords a means of combining the advantages of the two materials. Some prospective builders prefer the appearance of a cement stucco surface while still desiring the strength and solidity of concrete block walls.

When used as a foundation material for stucco, concrete blocks are made with a plain, flat face and no special effort is made to secure a smooth surface with sharp edges. Indeed, a moderate amount of roughness and irregularity is an aid in promoting the adherence of the stucco to the block. Since the two materials are practically identical in composition, this adherence or bond is unusually strong.

In applying stucco to blocks practically the same methods are followed as already described for brick. The mortar joints are scraped back to a depth of ½ or ¾ inch when the blocks are being laid, and the block well saturated just before the stucco is applied.

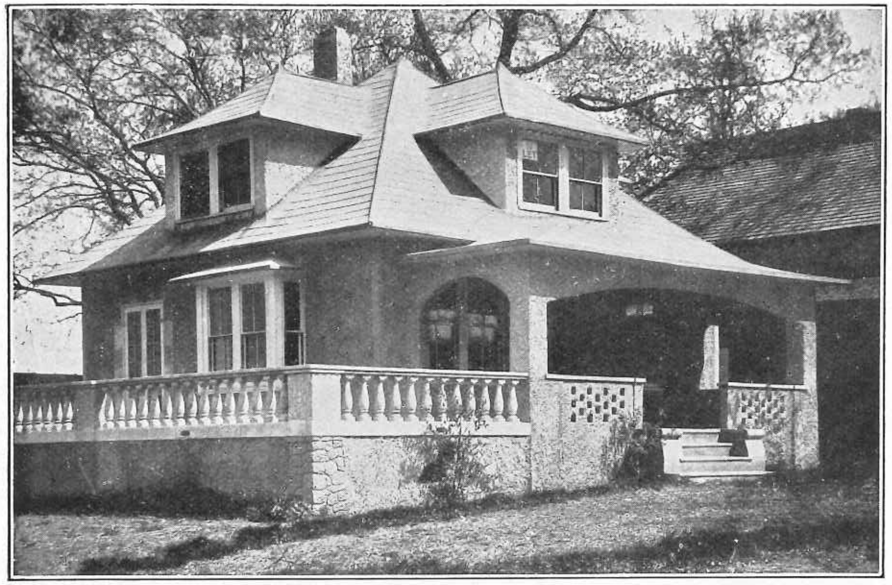

Fig. 12.—Small residence of stucco finished in rough cast surface.

There is now manufactured concrete tile designed especially as a foundation for stucco. They are made with two or more chambers separated by partitions, the walls and partitions being only ¾ inch thick. The blocks are therefore light, economical, and easily handled.

Since the concrete tile are made of the same material as the stucco, and of uniform composition and hardness, there is less likelihood of the outlines of the tile appearing through the stucco, as is sometimes the case when stucco is applied to a tile of different material.

Stucco on Frame Buildings

By far the most popular development of cement plaster work in this country is use of stucco for the exterior of frame buildings.

The great advantages of such an exterior as compared with shingle or clap-board work are responsible for this growing popularity. A stucco finish of Portland cement plaster is permanently enduring if properly applied. There is no cost required for painting or renovating. It never looks shabby, but continues to improve in appearance with age.

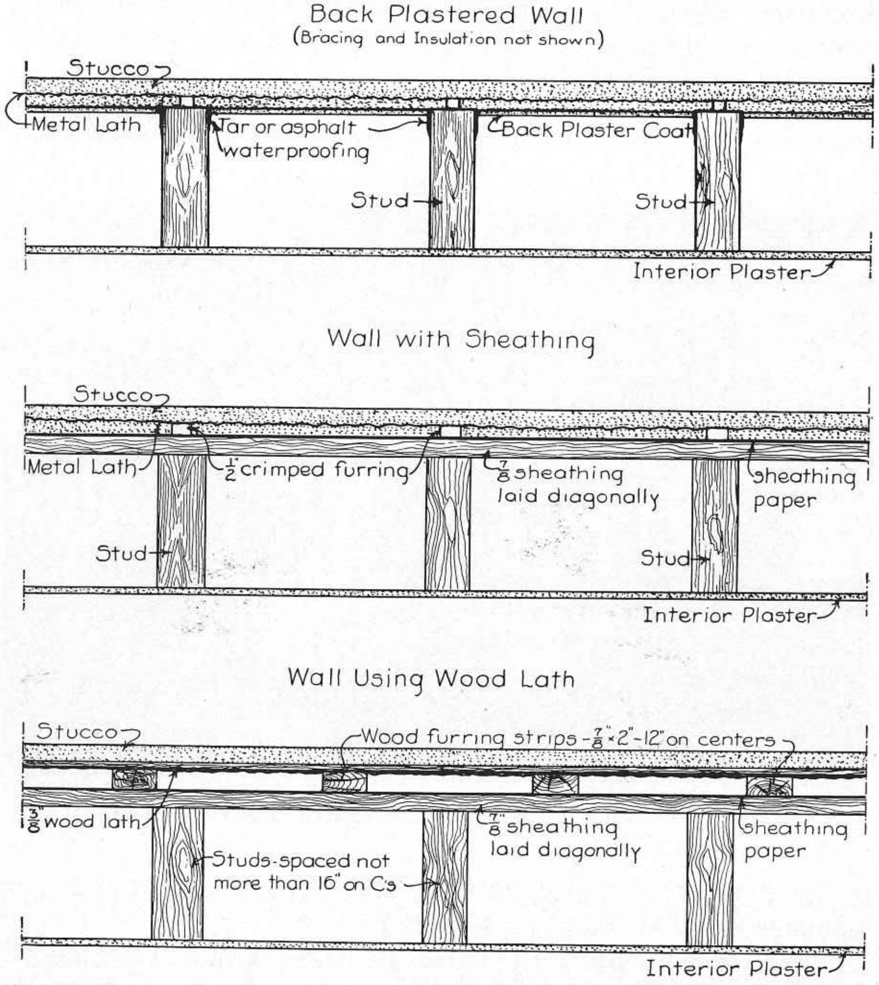

Fig. 13.—Section of walls showing three forms of stucco construction. For details see Specifications on page 10. (Details of interior plastering not shown in drawings.)

The artistic possibilities of surface finish and color contrast are numerous and are rapidly being recognized by progressive architects. The stucco exterior makes the house warmer in winter and cooler in summer, and it also adds greatly to the fireproof quality of the structure.

A detail in the construction of new stucco buildings is the proper provision for preventing the stucco of the walls from coming in direct contact with the ground. Although many houses are constructed in which the stucco extends to the ground line, there is always a possibility of the lath being corroded or rotted from the ground moisture—and in any case the splashing of rain-water from the ground upon the stucco serves to discolor and darken it.

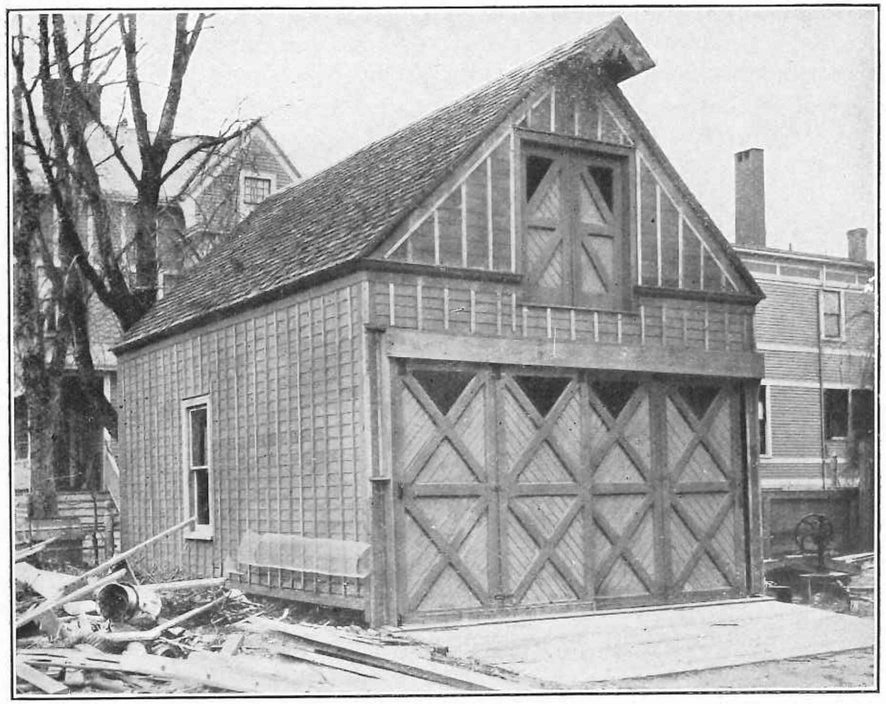

Fig. 14.—Frame stable being prepared for overcoating. Note furring strips and metal lath nailed thereon.

For these reasons the foundation or basement walls of the stucco house should extend about three feet above ground level, to furnish an adequate water-table. The walls should be made of concrete, surface-finished to conform with the stucco which adjoins.

In building a cement stucco-finished house, the usual construction is completed as far as the exterior sheathing. Precaution must be taken to make the framework as stiff as possible. The exterior sheathing is placed diagonally, so that no swaying will occur to crack the plaster, although metal lath reinforces the cement work considerably and prevents to a great extent any surface cracking. By covering the exterior of the sheathing with good heavy, waterproof building paper, the warmth of the house is increased.

Either wooden strips, as shown in Fig. 13, nailed directly to the sheathing over the building paper, can be used for furring strips or metal furring made especially for this purpose may be used. The metal strips are more satisfactory and are usually specified for use with metal lath. Metal furring is flat wire or band iron crimped for stiffness. It is set on edge and secured by staples to the sheathing. The wire or metal lath is wired to these staples. Some types of metal lath have the furring incorporated as part of the lath, separate furring then being omitted. Metal furring is made in widths of ¼ inch to 1 inch, and the quantities required are given in the following table:

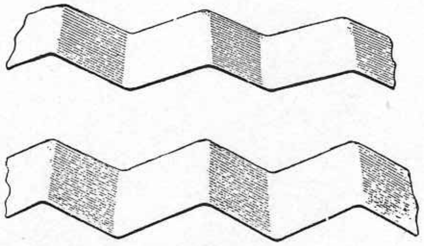

Fig. 15.—Metal furring.

QUANTITIES FOR 100 SQUARE YARDS OF LATH

Width of Furring	Material	Lineal Ft. Per Lb.	Pounds Required	
			12-Inch Centers	16-Inch Centers
¼ inch	Flat wire	20	50	37
½ " (specified) 22-gauge....	Band iron	20	40	34
¾ "	" "	15	67	45
1 "	" "	10	90	67

The furring strips should be spaced as directed in the specifications, and the lath attached directly to them. Either wood, wire-mesh, or metal lath can be used. If wood lath is used, it should be thoroughly saturated with water before the plaster is applied, or the moisture will be absorbed from the cement. Another method of preparing wood lath is to paint them with two coats of any of the reputable bitumen waterproof paints to which plaster adheres. After twenty-four hours and within six days of the application of the bitumen paint the plastering should be started. Metal lath should be galvanized or painted to assist in preventing corrosion.

Manufactured plaster-board or stucco-board in general requires no furring and comes ready for the application of the first coat.

After the lath is in place, the first coat of Portland cement stucco should be applied. Only a small quantity of plaster should be mixed at one time, so that the cement does not have an opportunity to set before being used. The proper proportions for each coat are given in the specifications on page 10. The materials should be thoroughly mixed dry, and then water should be added until the mortar is made the proper consistence for plastering.

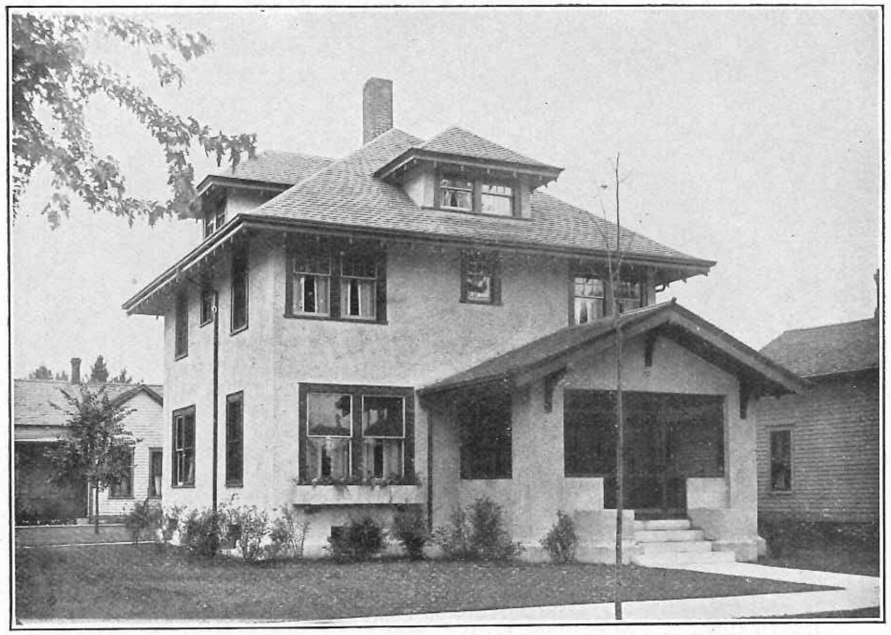

Fig. 16.—This house indicates the pleasing effect obtained by the use of dark-finished window frames and trim in contrast with light-colored stucco.

The plastering should be started at the top, and the work carried downward continuously without allowing the plaster to dry at the bottom edge. If it is impossible to work the full width of the wall at one time, make the break come at some natural division of the surface, such as a window or door. The plaster must be forced well into the meshes of the lath so as to form a good key. If metal lath or wire is used, a small-sized mesh is preferable, not larger than ⅜ by ⅝ inch, as there is a tendency for the plaster to drop through a large mesh, which causes considerable waste. The plaster should not be troweled too much—just enough to force it through the lath and to bring it to the required thickness. While the first coat is wet, it is scratched deeply over the entire surface, and as soon as it has set sufficiently to support the second coat it is applied.

If a thick plaster is desired, a third coat is applied when the second coat is strong enough to support it, the second coat having been scratched as was the first coat. Hair is used only in the first coat of plaster, and the finish is usually obtained from the third coat. Three coats are recommended for use on metal lath. To obtain uniform results as to color and texture each batch of plaster must be mixed in the same proportions as the preceding one, with the same amount of water.

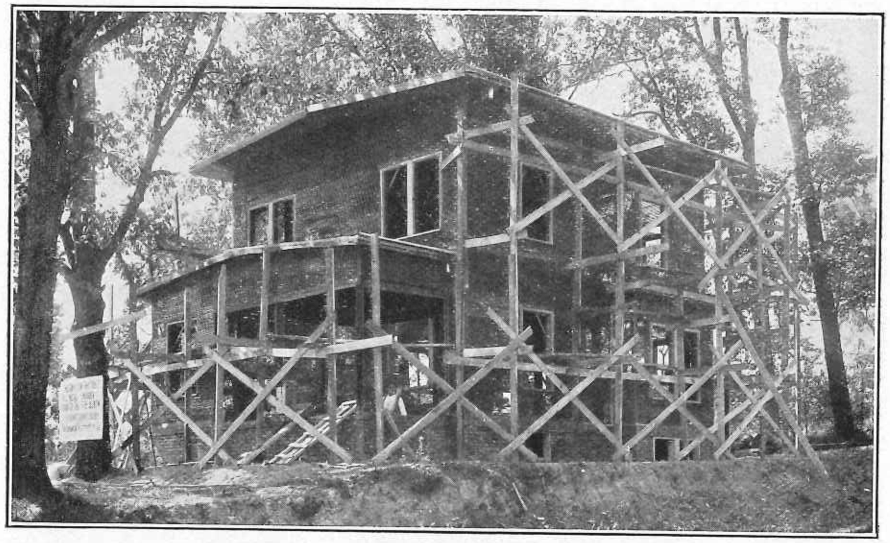

Fig. 17.—Residence with metal lath in place and ready for the first stucco coat.

Metal Frame Stucco Houses

Recently there have been placed on the market specially designed structural steel members for making the framework of stucco houses. These members are so constructed that a locking device permits the component parts to be firmly locked together at the proper points. By the use of such members a very rigid and indestructible frame is secured. This form of construction is particularly applicable for the building of houses for workmen where a number of similar houses are built at one operation.

The roof and floors are constructed of concrete reinforced with metal lath so that practically no form work is required for the entire structure.

SURFACE FINISH AND COLORING

The architectural possibilities of Portland cement stucco houses are many and varied. The surface can be treated in any of the various methods

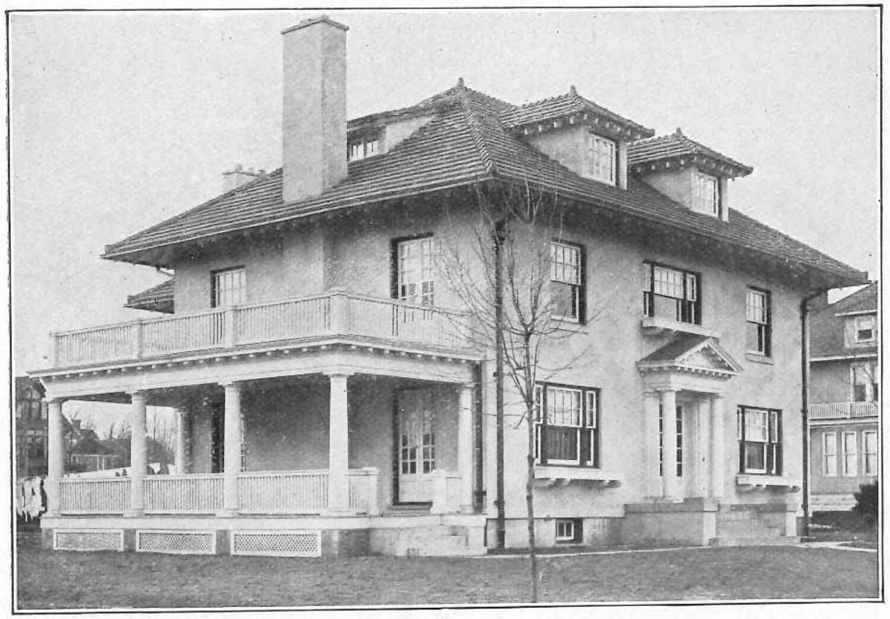

Fig. 18.—Residence finished with plain sand-floated surface.

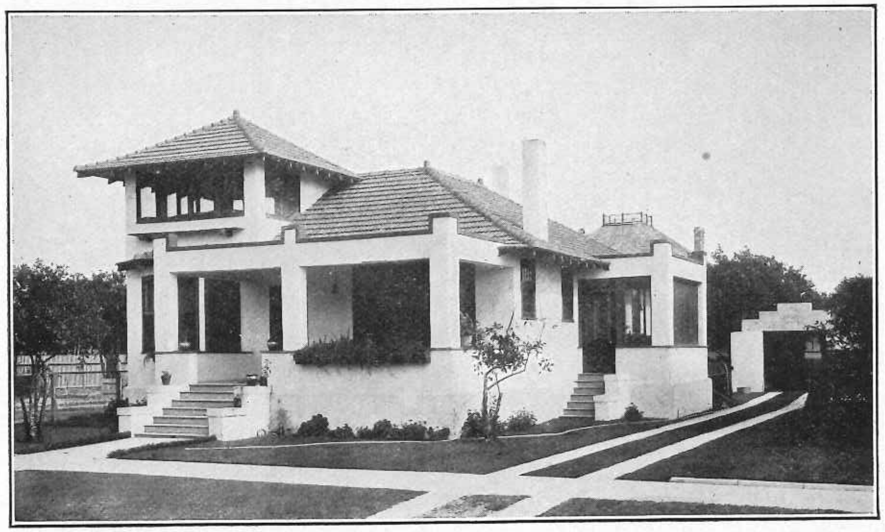

Fig. 19.—Stucco is fitted for practically any style of architecture. Note concrete runways and garage.

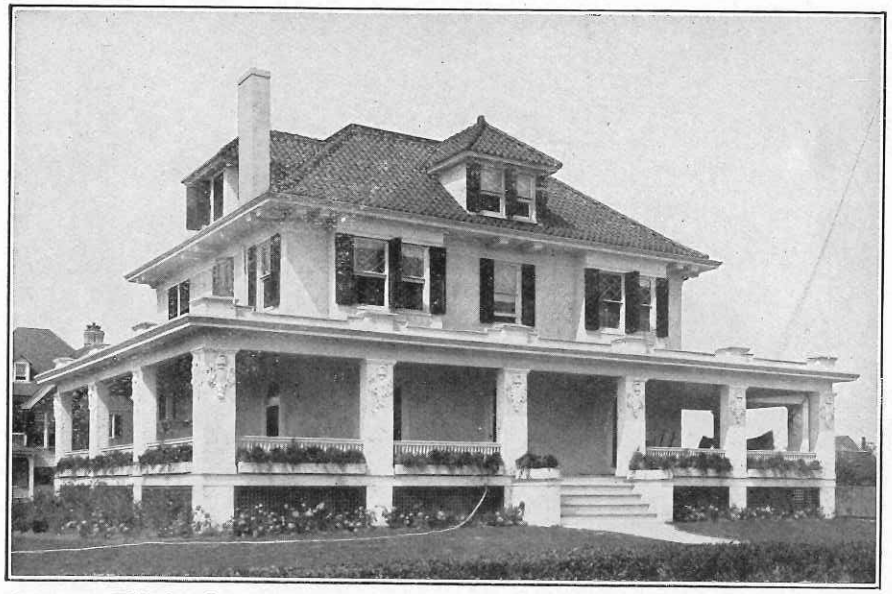

Fig. 20.—This handsome residence illustrates the use of ornamental details, which appear in relief on the veranda columns.

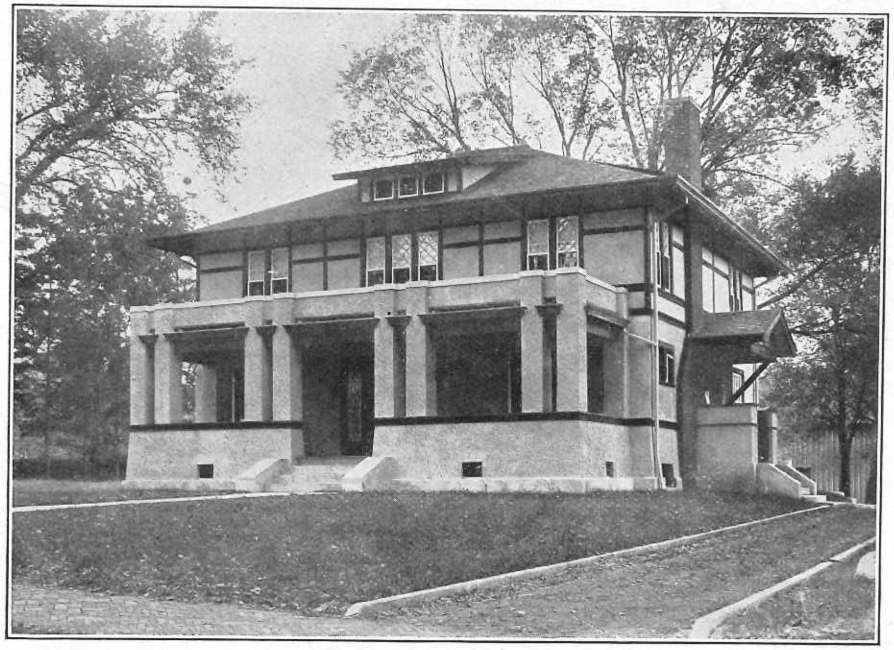

Fig. 21.—A partial half-timbered effect, with wide overhanging eaves. Proper provision for roof-water is essential to prevent staining or discoloration of stucco.

described, and in addition to this the stucco can be colored in many ways. Mix the coloring-matter thoroughly as directed on page 17.

One of the most important questions, and one that is bound to arise whenever the use of coloring-matter in cement is contemplated, is that of permanency. Blacks are safe colors, as a rule, although it is better to avoid experiments with cheap blacks. The carbon blacks are preferable to lampblacks, because they do not have the same tendency to float to the top during mixing. There are fewer grades of carbon blacks, and there is, therefore, less likelihood of getting a worthless color. Ultramarine blue, if of good quality, will hold its color for a number of years, and generally possesses the virtue of fading out evenly, when it does finally lose its color. It cannot be classed as a permanent color, as is black, brown, or ochre.

TABLE OF COLORS TO BE USED IN PORTLAND CEMENT

Color Desired	Commercial Names of Colors for Use in Cement	Approximate Prices Per Lb. in 100-lb. Lots for High-Grade Colors	Pounds of Color Required for Each Bag of Cement to Secure—	
			Light Shade	Medium Shade
Grays, blue-black and black	Germantown lampblack	10 cts.	½	1
	Carbon black	8 "	½	1
	Black oxide of manganese	6 "	1	2
Blue shade	Ultramarine blue	18 "	5	10
Brownish-red to dull brick red	Red oxide of iron	3 "	5	10
Bright red to vermilion	Mineral turkey red	15 "	5	10
Red sandstone to purplish-red	Indian red	10 "	5	10
Brown to reddish-brown	Metallic brown (oxide)	4 "	5	10
Buff, colonial tint, and yellow	Yellow ochre	6 "	5	10
Green shade	Chromium oxide	26 "	5	10

Reds and browns need little comment in addition to the explanation given in the Table of Colors. Do not try to secure a bright red shade with the ordinary red oxide of iron at 3½ cents a pound. These colors are permanent if of high grade.

Yellow ochres offer a wide variety of shade and quality. French ochre, if genuine, is safe to use, and with it most attractive colonial yellow and buff tones can be secured. There are a number of good yellow ochres manufactured in this country, but naturally they are not of the cheapest variety. It is always safe to know the name of the manufacturer, and also whether or not the color was specially designed for coloring cement.

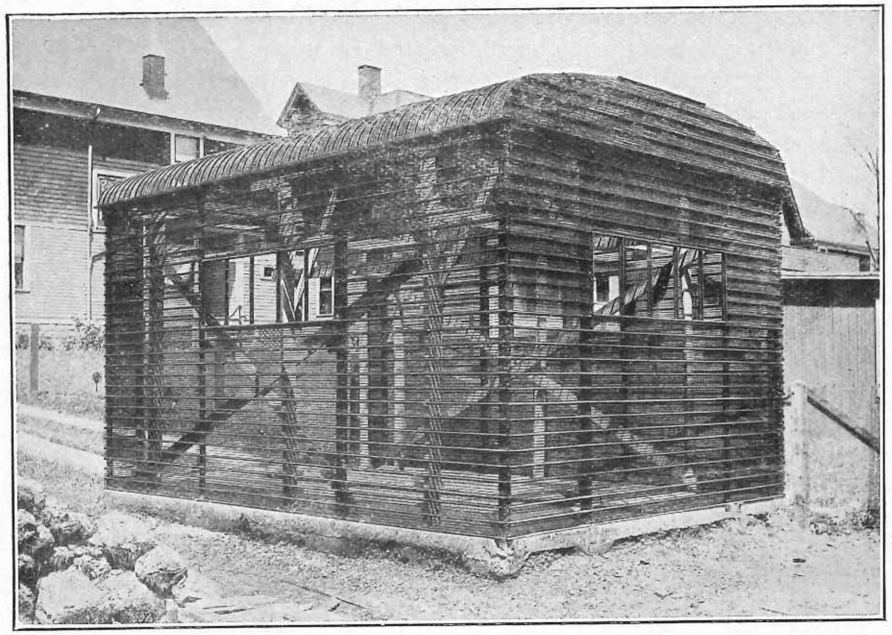

Fig. 22.—Small garage with metal lath ready for first coat. Note that this building is without sheathing and thus intended for back-plastered wall construction.

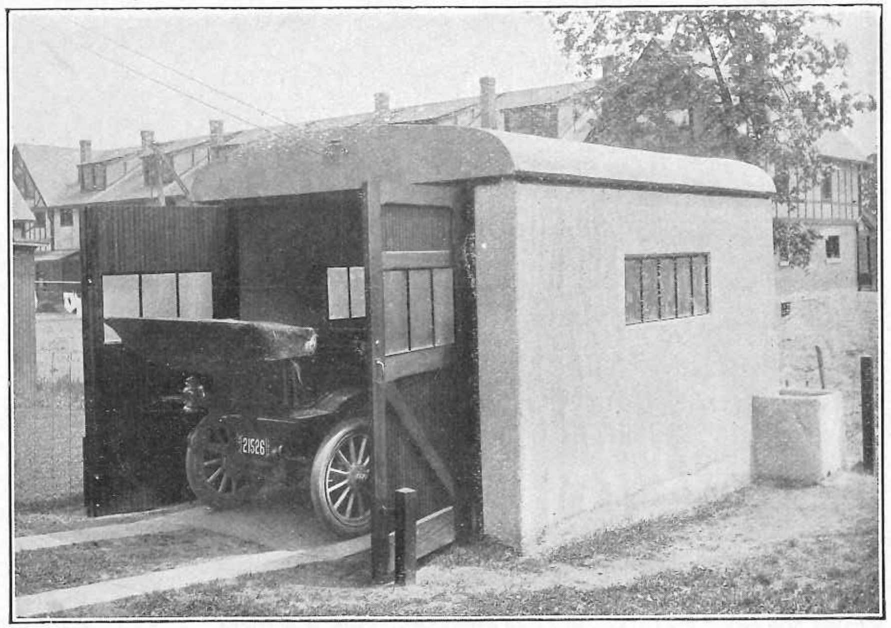

Fig. 23.—Garage shown above when finished. Note concrete roof and runways.